J Forensic Sci, Jul. 1972, Vol. 17, No. 3

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Variations in Wounding Due to Unusual Firearms and Recently Available Ammunition

The 1960's witnessed a sharp rise in the number of murders in the United States. Murders increased from 9000 in 1960 to 14,590 in 1969. While firearms were used in 54 percent of the murders in 1962, by 1969 this percentage had risen to 65 percent [*1*]. At the present time, almost two-thirds of all homicides encountered by a pathologist will have been committed with firearms. Unfortunately, many pathologists are uninterested in firearms cases and handle them in a routine manner showing little imagination and having as their sole aim the recovery of a bullet for ballistics examination. If a pathologist maintains this attitude, he will miss significant findings concerning the weapons used. Some of these findings may be made only by a thorough postmortem examination.

Further complicating this situation is the fact that many pathologists are unaware of the vast changes in weapons and ammunition that have occurred in the last twenty-five years. Since 1946, over 55 million new and used firearms have been purchased in the United States [*2*]. Newly designed weapons of both domestic and foreign manufacture as well as obsolete military weapons from all over the world have been sold. Many of these weapons are chambered for cartridges never before seen in quantity in this country. New domestic cartridges as well as modifications of old familiar cartridges have also appeared. These facts must be realized by the pathologist when handling firearms cases.

An obstacle to the proper evaluation of gunshot wounds in general, as well as injuries caused by the newer weapons and ammunition, is the inadequacy of the standard forensic pathology textbooks [*3,4,5*]. These works not only fail to give sufficient coverage to firearm wounds but, in many cases are outdated 25 years or more in their coverage and information.

This paper will present a series of firearms cases, all characterized by an unusual aspect to either the wound, the weapon, or the ammunition. An attempt will be made to acquaint the pathologist with some unusual firearms injuries, as well as some of the recent advances in firearms which may be of significant interest to him. In order to limit the scope of this paper and because pistols are used in the majority of firearms homicides, only these weapons and their ammunition will be considered.

Ball Powder

In the early 1930's, Winchester introduced a new form of smokeless powder called "ball powder" [*6*]. The grains of this powder are in the shape of small spheres rather than

Presented at the 23rd Annual Meeting of the American Academy of Forensic Sciences, Phoenix, Ariz., 25 Feb. 1971, under the title "Wound Patterns Due to Injury by Uncommon Firearms."

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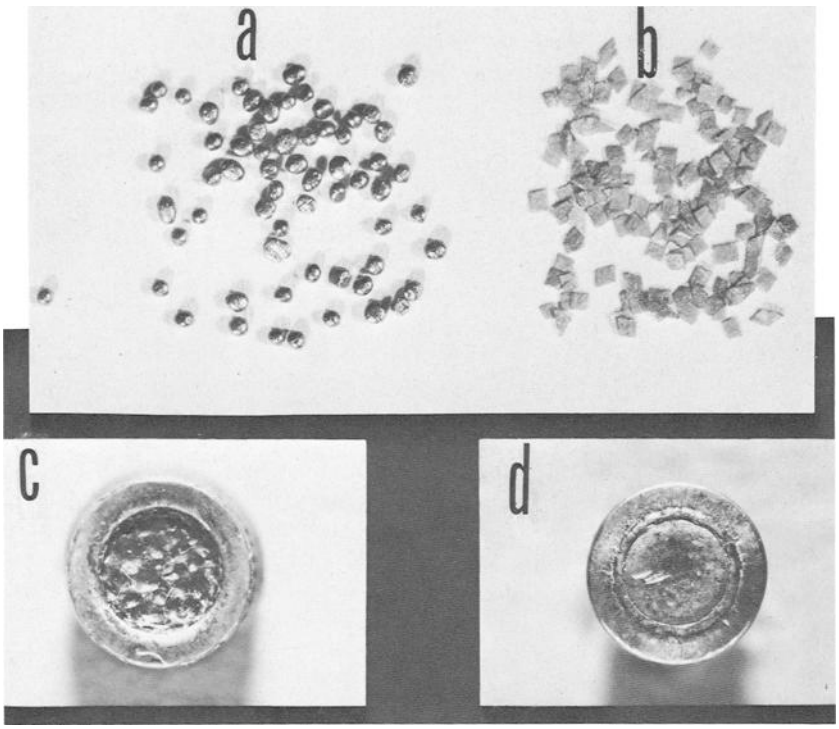

FIG. 1—(a) *Ball powder;* (b) *flake powder;* (c) *cratered base of bullet due to ball powder;* (d) *base of unfired bullet.*

the traditional flakes or cylinders (Fig. 1*a*, *b*). Many of the pistol cartridges produced at present by Winchester Weapons are loaded with ball powder. Examination of a bullet fired from such a cartridge shows the lead base to have a cratered appearance with numerous little pockmarks most frequently but not invariably due to use of ball powder as a propellant (Fig. 1*c*). This feature was observed in the following case.

A twenty-five year old Negro male was found shot to death in a Baltimore park. A large irregular shaped gunshot wound was present in the forehead. There was powder blackening of the inner and outer tables of the skull surrounding the entrance hole. The irregular nature of the entrance wound in the soft tissue was due to rodents nibbling on the margins of the wound. Recovered from the brain was a .25 caliber, full metal-jacketed bullet with its base bearing the impressions characteristic of ball powder. This was further confirmed by the recovery of unburnt ball powder grains from the soft tissue surrounding the entrance wound.

Since most ammunition is not loaded with ball powder, it may be important for probable exclusion purposes to determine when it is used. If in this particular case, the bullet had exited the body, examination of the entrance wound alone would have revealed that ball powder was used. If on the other hand, the gun had been fired at a distance and the bullet retained, examination of the base of the bullet would have shown that ball powder was most likely used.

Powder Patterns

All forensic pathologists are familiar with the fouling and smudging of contact gunshot wounds and the powder stippling of close up wounds. In the vast majority of cases, however, there is nothing sufficiently characteristic to enable identification of the weapon. The two cases to be presented are exceptions.

A twenty-three year old Negro male was found dead in his room with a .22 caliber pistol beside the body. There was a contact gunshot wound of the left chest with a bullet hole in the overlying teeshirt. Interest was immediately drawn to the shirt because of the unusual powder pattern present. Beginning at a point ½ in. from the hole in the shirt at the 10 and 2 o'clock positions were two radially oriented powder smudges 1 in. long and slightly less than ½ in. wide (Fig. 2*a*). Because of the curious pattern, the gun was requested from the police and examined by us. The weapon was a Hi Standard "Olympic" target pistol equipped with a muzzle-brake (Fig. 2*b*). The muzzle-brake operates by diverting two jets of gas from the barrel in an upward and forward motion. These two streams of gas caused the blackening observed.

The second unusual powder pattern was seen in the suicide of a twenty year old Puerto Rican male who shot himself twice in the chest. The two contact wounds showed extensive blackening of the skin. One and one-quarter inches superior to each entrance wound was a small irregular area of blackening and powder burning (Fig. 3). The two .22 caliber bullets recovered from the body were free of rifling.

Examination of the suicide weapon showed it to be a .22 caliber starter pistol whose barrel had been reamed open. Present on the top of the barrel was a vent intended to channel off gases when blank cartridges were fired. This vent directed some of the gases in an upward and forward direction causing the patterns observed.

FIG. 2—(a) *powder pattern on shirt;* (b) *weapon equipped with muzzle break.*

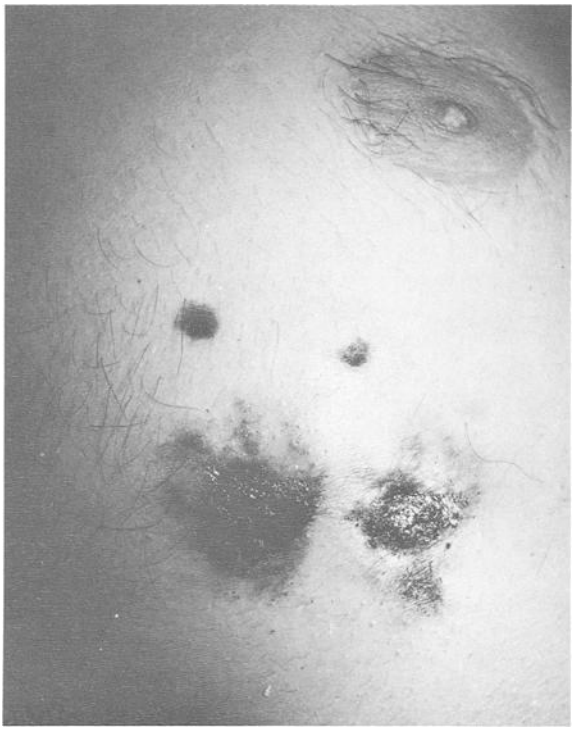

FIG. 3—*Powder pattern on chest.*

In these two cases, the weapons used at contact range caused unusual and characteristic powder patterns. Tentative identification of the general type of weapons used could be made from these observed patterns. In both cases, the observations are of only academic interest since the weapons were at the scene. However, the information as to type of weapon would be of great importance if these deaths had been homicidal and the weapons unknown.

Cap Firing Conversions

A zip-gun is a crude, homemade, single shot firearm [7]. Conversion of a toy cap pistol to fire ammunition is a major improvement over the zip-gun. Both these weapons are more commonly encountered in areas where there is restrictive firearms legislation as they can be manufactured with few tools and limited skill.

Cap pistols are usually light metal castings held together by rivets. They are converted to weapons by inserting a piece of car radio antenna or similar metal tubing in the barrel and providing a firing pin. This firing pin may be made by filing the hammer to a point or by inserting a nail or screw. A .22 caliber cartridge is used in this type of gun. If the hammer fall is too light, it may be strengthened by wrapping rubber bands around the frame and back of the hammer.

In the case illustrated, a 15 year old white male committed suicide by shooting himself in the left temple. The weapon used was a toy derringer in the upper barrel of which a portion

of radio antennae had been inserted (Fig. 4). Externally, there is nothing characteristic about wounds produced by these weapons. However, when the pathologist recovers the bullet, he will find that there is a complete absence of rifling marks. This is encountered in zip-guns, cap-firing conversions, and blank-firing pistol conversion.

Plastic Ammunition

With the increasing popularity of hand-gun shooting, there arose a demand for a relatively safe and inexpensive form of ammunition suitable for indoor practice. This led to the development of plastic ammunition consisting of a reusable plastic case and bullet propelled only by a large pistol cartridge primer (Fig. 5*a*). The bullet is a cylindrical piece of plastic. One of the principal manufacturers of this ammunition states that the plastic bullet is propelled over 500 ft/s [*8*].

Tests were conducted to see how dangerous these projectiles really are. Test firings were conducted on bodies at distances varying from contact to 20 ft. In no instance did the projectiles penetrate the body. The wounds inflicted were limited to the skin, consisting of superficial circular lacerations whose diameter corresponded to that of the projectile (Fig. 5*b*). These findings lend support to the claims of the relative safety of this ammunition. While these projectiles are not capable of penetrating the skin to any significant degree, they would be capable of penetrating the eye and should be used with caution.

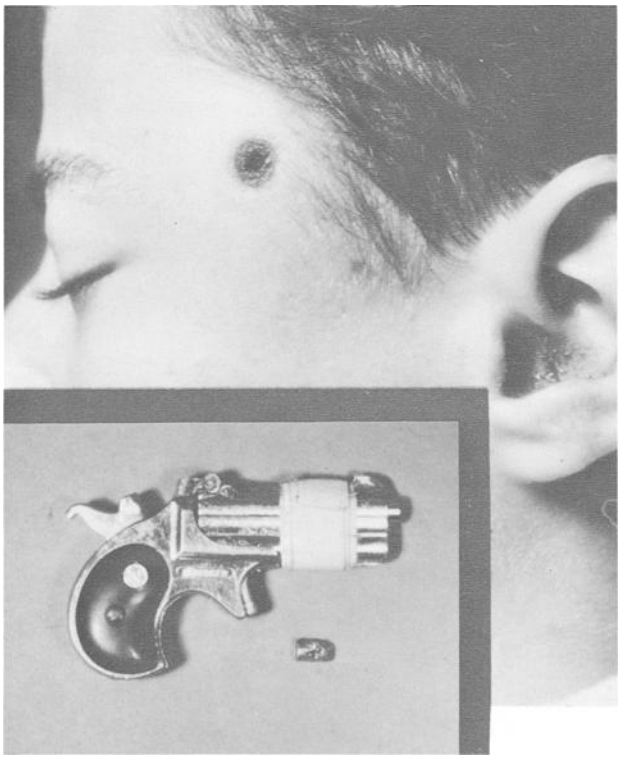

FIG. 4—*Contact entrance wound, left temple; weapon and cartridge case.*

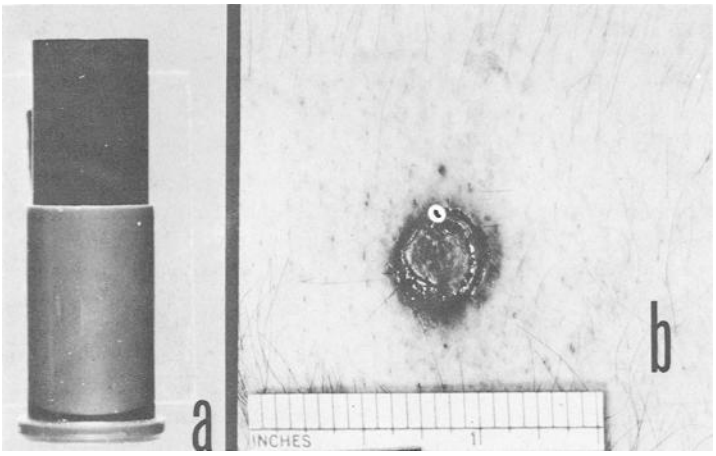

FIG. 5—(a) *Plastic bullet and cartridge case;* (b) *wound.*

.22 Caliber Frangible Bullets

.22 caliber frangible bullets are used in shooting galleries to prevent ricochets which may occur with solid lead bullets. These bullets composed of bonded fragments of iron or lead, disintegrate on striking the target. Graham et al [*9*] reported a death resulting from a penetrating wound of the head and brain from such a projectile. These authors conducted a series of tests with frangible bullets and came to the conclusion that they are of considerable forensic significance. The tests showed that frangible bullets, besides having a strong tendency to fragment, are unsuitable for ballistics comparison due to erosion of the bullet's surface.

In our case, a 43-year old white female was raped and murdered in her apartment. The deceased had been beaten, struck about the head and strangled with a ligature. Autopsy revealed a gunshot wound of entrance of the back of the head. A flattened .22 caliber bullet weighing 25.6 grains was recovered from beneath the scalp. There was no penetration or fracture of the skull. The bullet was readily identified as a frangible lead bullet. Examination of it revealed faint rifling unsuitable for ballistic comparison because of the essentially frangible nature of the projectile.

Stud Guns

Stud guns are industrial tools used for firing metal studs into steel, wood, or concrete. The propellant is a special cartridge which may vary from .22 to .38 caliber. Spitz and Wilhelm [*10*] recently published a paper on experimentally induced stud gun injuries. They stated that they knew of no purposely inflicted stud gun injury in the literature. Since then such a case has been encountered.

A 50-year old white male was found dead in bed with what appeared to be a stellate shaped contact gunshot wound of the forehead (Fig. 6*a*). Alongside the body was a stud gun containing a fired .22 caliber propellant cartridge (Fig. 6*b*). At autopsy, there was a perforating missile wound of the skull and brain. There was no visible blackening of the skin, soft tissue, and skull. Subsequently, the nail-like stud fired from this gun was recovered from the wall behind the victim's bed.

All stud guns have a built-in safety device that requires a guard at the tip of the gun be pressed firmly against a flat surface before it can be discharged. The deceased in this case pressed the weapon firmly against his forehead depressing the safety guard. A discussion with a worker who used this type of tool in his trade, revealed that he and other workers have used these weapons for "plinking." They depress the safety guard with one hand and fire the tool with the other. Targets have ranged from tin cans to rabbits.

Interchangeable Cartridges

Many physicians are unaware that some guns are capable of firing cartridges of different caliber. In some cases, this is intentional, that is, the weapon has been designed to do this. An example is the H & R Model HK-4, which by the changing of the barrel and magazine, can fire .22 long rifle, .25 automatic, .32 automatic, and .380 automatic cartridges.

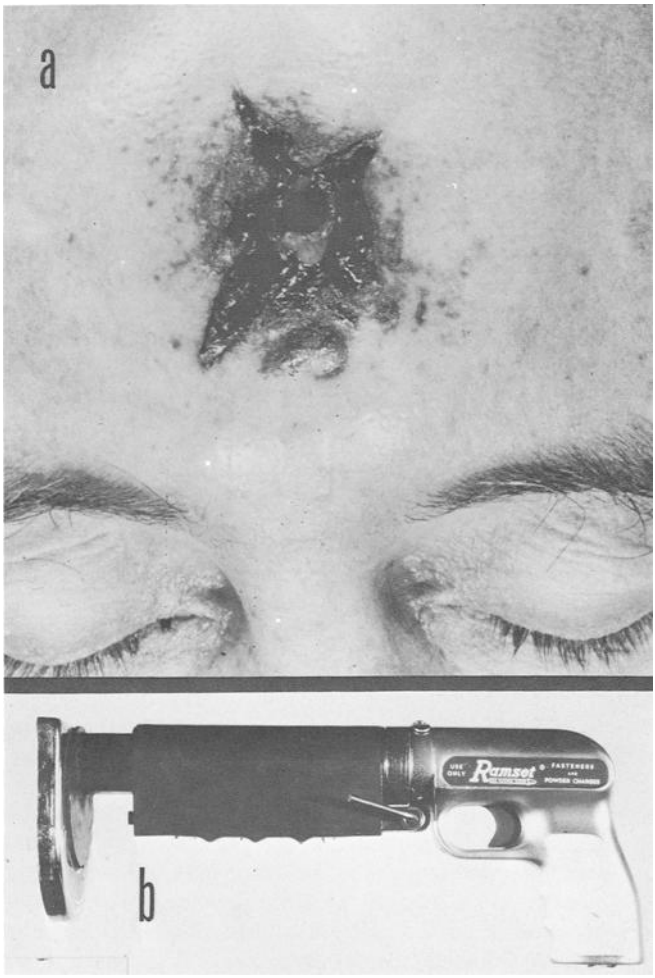

FIG. 6—(a) *Entrance wound in forehead;* (b) *weapon.*

Cartridges may also be fired in weapons never designed to handle them with unusual consequences [*11*]. The most notorious automatic weapon in this category is the Astra pistol. Chambered for the 9-mm Bergmann-Bayard cartridge, this weapon has had various types of 9-mm cartridges fired from it [*12*].

More commonly encountered and of more importance to the forensic pathologist is the practice of firing .32 automatic ammunition in .32 revolvers. This is due to either a shortage of ammunition or ignorance. Because the .32 automatic cartridge is not truly rimless but actually semi-rimmed, it will chamber and fire in a .32 revolver without any difficulty [*13*]. The following case illustrates this.

A 21-year old Negro male was shot three times during an altercation. The assailant used a .32 caliber revolver which was subsequently recovered. At autopsy, three bullets were recovered from the body. Two of these were .32 caliber full metal-jacketed bullets and one was a .32 caliber lead revolver bullet. If the crime had not been witnessed, the recovery of two different bullets would have suggested that two different weapons and probably two different individuals were involved.

KTW Ammunition

A new specialized form of ammunition has recently appeared on the market. This is the KTW metal-piercing cartridge designed for penetrating engine blocks and the skin of automobiles [*14*]. This ammunition is available in several different pistol calibers as well as .30 carbine. The cartridges are loaded with a teflon-coated tungsten alloy bullet with a gilding metal half jacket on its base. This half jacket serves as a rotating band for the lands and grooves to grip. The .38 Special KTW is the caliber most likely to be encountered by the pathologist.

The KTW cartridge will present a problem to the pathologist only if he is unaware that the bullet may shed its half jacket in passing through a body. This jacket is necessary for ballistic identification as the barrel markings will be found only on it and not on the bullet (Fig. 7). In a test carried out by us, the bullet perforated a body going through the vertebral column and penetrating, to a depth of 1 in., a wooden beam behind the body. The bullet shed its half jacket just under the skin at the exit site. If this had been an actual case, the pathologist would have been presented with a perforating wound in a victim and the story of a bullet being recovered at the scene. If he did not do a thorough autopsy, he might very well have missed the jacket at the exit site and made ballistic comparisons impossible. X-ray films of the body, of course, would reveal the presence of the jacket.

Super Vel Ammunition

The .38 Special is the most widely used police cartridge in the United States. Recently, many police departments have begun to complain that this cartridge is not an effective "man-stopper" [*15*]. To remedy this deficiency, manufacturers have developed a new loading for the .38 Special. This load consists of a light-weight, semi-jacketed bullet propelled at a higher velocity. The pioneer in the development of this type of ammunition has been the Super Vel Corporation. They produce a .38 Special cartridge loaded with a 110-grain partial-jacketed, semi-wadcutter bullet, whose muzzle velocity is 1370 fps and whose muzzle energy is 458 ft·lbs. In comparison, the standard .38 Special loaded with a 158 grain round nose bullet has a muzzle velocity of 855 fps and a muzzle energy of 256 ft·lbs. The Super Vel bullet comes in two designs: a flat nose soft point and a hollow point.

We decided to conduct a limited series of experiments using Super Vel ammunition to determine whether these cartridges produced greater injury than the ordinary .38 Special.

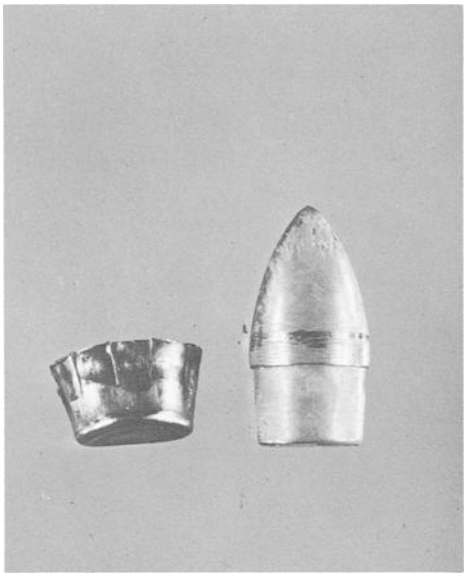

FIG. 7—*Fired KTW bullet with detached half jacket. Rifling marks present on half jacket only.*

Test firings were confined to the thoracic region of unautopsied bodies and were conducted at a distance of 10 ft. Both Super Vel hollow point and soft point ammunition were used.

The entrance wounds in the skin were identical to those produced by the standard .38 Special round. On reflecting the skin, the Super Vel entrance wounds in the thoracic wall were seen to be at least 2 to 3 times the diameter of those produced by the standard 158-grain round nose bullet (Fig. 8). This finding was unrelated as to whether the bullet struck a rib. A difference was also noted in the wounding ability of the two types of Super Vel ammunition. The entrance wounds from the hollow point bullets were larger and more irregular than those caused by the soft point bullets. The greater wounding ability of the hollow point is apparently due to their tendency to mushroom on penetrating tissue. The jacket peels back allowing the lead core to expand.

The exit wounds in the skin caused by the Super Vel hollow point were slightly larger than those of the Super Vel soft point and the ordinary .38. The size of the exit wounds depended on the shape and size of the bullet as it exited the body, the mushroomed hollow point bullets causing larger exit wounds.

Summary

The standard textbooks in forensic pathology are seriously deficient in their coverage of matter relating to gunshot wounds. Not only do they fail to give sufficient coverage to this topic, but they also have failed to keep pace with developments in the field of firearms and ammunition. An attempt has been made to update our knowledge of firearms injuries by utilizing a combination of experimentation and case presentation.

Acknowledgments

We wish to thank D. J. DiMaio, M.D., Deputy Chief Medical Examiner, Borough of Brooklyn, New York City, for permission to use four of his cases in this paper.

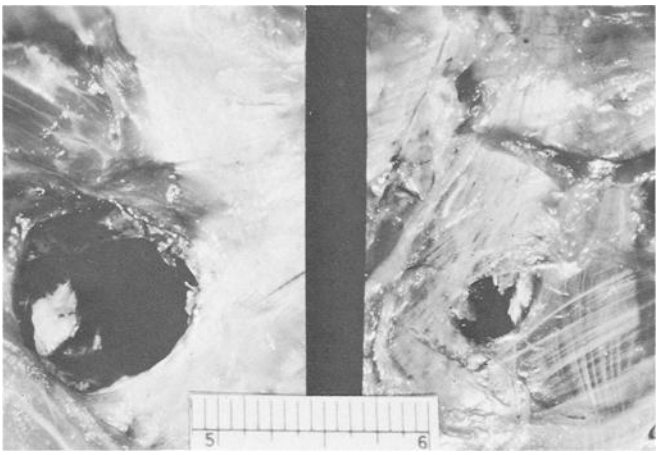

FIG. 8—*Entrance wounds of chest wall, skin retracted. Left: Super Vel soft point, right: 158-grain lead round nose.*

References

[*1*] Hoover, J. E., "Crime in the U.S.," *Uniform Crime Reports—1969*, U.S. Government Printing Office, Washington, D.C., 1970.

[*2*] *Firearms and Violence in American Life*, staff report to the National Commission on the Causes and Prevention of Violence, U.S. Government Printing Office, Washington, D.C., 1970.

[*3*] Polson, C. J., *The Essentials of Forensic Medicine*, 2nd ed., Pergamon Press, New York, 1965.

[*4*] Gonzales, T. A., Vance, M., Helpern, M., and Umberger, C. J., *Legal Medicine*, 2nd ed., Appleton-Century-Crofts, 1954.

[*5*] Camps, F. E., *Gradwohl's Legal Medicine*, 2nd ed., Williams and Wilkins Co., 1968.

[*6*] *N.R.A. Illustrated Reloading Handbook*, National Rifle Association of America.

[*7*] Koffler, B. B., "Zip Guns and Crude Conversions—Identifying Characterization and Problems, I, II," *Journal of Criminal Law, Criminology and Police Science*, Vols. 60 and 61, 1969–1970, pp. 520–531 and 115–125, respectively.

[*8*] Speer Products Co., Lewistown, Idaho.

[*9*] Graham, J. W., Petty, C. S., Flohr, D. M., and Peterson, W. E., "Forensic Aspects of Frangible Bullets," *Journal of Forensic Sciences*, JFSCA, Vol. 11, 1966, pp. 507–515.

[*10*] Spitz, W. U. and Wilhelm, R. M., "Stud Guns Injuries," *Journal of Forensic Medicine*, Vol. 17, 1970, pp. 5–11.

[*11*] Mason, M. F. and Rose, Earl, "Four Nonlethal Head Wounds Resulting from Improper Revolver Ammunition," *Journal of Forensic Sciences*, JFSCA, Vol. 12, 1967, pp. 205–213.

[*12*] Monte, G. C., "What Interchangeable 9 mms?," *Gun Digest*, 25th ed., 1971, pp. 185–189.

[*13*] Smith, W. H. B. and Smith, J. E., *Book of Pistols and Revolvers*, 7th ed., Stackpole Books, Harrisburg, Pa., 1968.

[*14*] KTW, Inc., 710 Cooper-Foster Park Road, Lorain, Ohio, 44053.

[*15*] Olt, J. R., "The .38 Special," *Gun Digest*, 25th ed., 1971, pp. 168–173.